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# Depositional vs. erosional coastal carbonate systems in Puglia (southern Italy) and their response to relative sea-level changes: modern and ancient examples

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## Abstract

This work, mainly based on a synthesis of published data, talks about both modern and ancient (Plio-Pleistocene) temperate-water shallow-marine carbonate systems developed in wave-dominated settings in Puglia (southern Italy), and their response to relative sea-level changes.

Temperate-water carbonate factories and their open-shelf/ramp systems, are subjected to many of the same physical processes (i.e. hydrodynamic) that affect sediments in siliciclastic shelf systems (James, 1990; Tucker and Wright, 1990) as temperate-water carbonate systems are not bordered by protective shallow-water barrier reefs or shoal-rims.

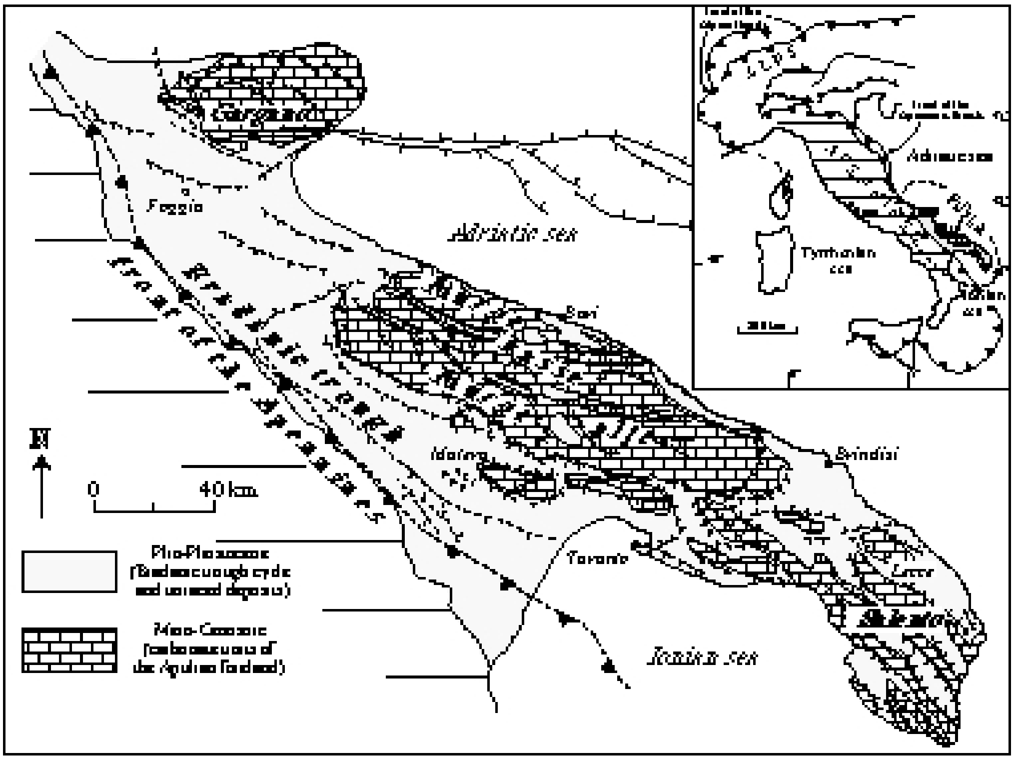


**Figure 1.** Schematic geological map of the Puglia region. The studied Plio-Pleistocene carbonate deposits (the Calcarenite di Gravina Formation) crop out around the structural highs of Murge.

Along high-energy wave-dominated coasts, as considered here, three distinctive zones are commonly distinguished in siliciclastic systems; beach (backshore and foreshore), shoreface and offshore-transition. The beach zone occurs in an emerged and intertidal coastal setting, the shoreface extends from mean low-water level to mean fair-weather wavebase, and the offshore-transition zone extends from mean fair-weather wavebase to mean storm wavebase; offshore facies are deposited in areas below mean storm wavebase (mid and outer shelf/ramp) (e.g. Reading and Collinson, 1996).

Open-shelf and ramp carbonate systems should display facies similar to those characteristic of shallow-marine siliciclastic systems (Burchette and Wright 1992), but a rather different environmental zonation has been proposed from the study of modern and fossil temperate-water carbonate systems in Australia. The base of wave abrasion and base of swells divides these systems into (i) a nearshore abrasion zone that corresponds to the inner shelf/ramp where rates of erosion and offshore sediment transport are higher than those of carbonate production, (ii) a swell zone that represents the mid shelf/ramp where the sediments produced *in situ*, derived from the nearshore zone, and relict ones are frequently reworked by waves and bioturbated and, (iii) a deeper zone of the outer shelf/ramp where non-phototrophic carbonate production occurs (James et al. 1992; Boreen and James 1995; Wright and Burchette 1996; James and Clarke 1997).

Therefore, in contrast with their siliciclastic counterparts, temperate-water carbonate systems are characterized by a nearshore zone of no deposition, where waves and currents reach and abrade older soft-sediments or rocks.

Moreover, waves activity in the nearshore zone may move sediments landward, to form small beach along protected bays. Consequently these carbonate systems are characterized along their depositional profile (from shoreline to offshore) both by depositional and erosional environments. Similar systems dominate, and dominated during Plio-Pleistocene times, shallow-marine settings of Puglia.

For example, along the western Salento peninsula, present-day coasts are characterized by an extremely irregular series of bioclastic pocket-beaches and rocky coasts. Beach bodies, composed of not-relict and mainly skeletal carbonate grains, are <2-4 km in length, <10-20 m wide, from few tens of centimetres to few metres thick, and rest on a rocky substratum.

Sediment distribution drastically reduces nearshore in 3-7 m water depth, with deeper shore or coastal environments characterized by a rocky seafloor (Dal Cin and Simeoni 1987); offshore, shelf is again characterized by the presence of carbonate sediments (Viel and Zurlini 1986; Aiello et al. 1995).

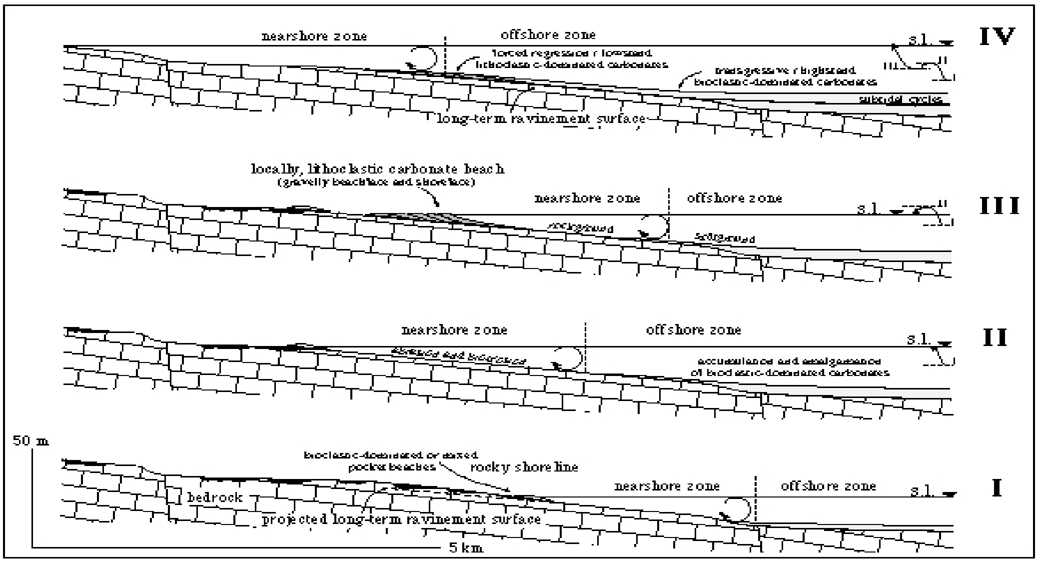


**Figure 2.** Development of reciprocal sedimentation in the Calcarenite di Gravina Fm. During relative sea-level rise temperate-water carbonate systems dominated on the Murge flanks and an erosional transgression took place (**I** and **II**). Relative sea-level changes led to the development either of carbonate subtidal cycles or, in terrigenous fed coasts, of reciprocal sedimentation. During lowering of sea level, lowstand clastic coastal deposits frequently occupied the non-depositional nearshore zone of the preceding highstand non-tropical system, as indicated by the presence of conglomeratic beds on the abraded and bored bedrock (**III**). During the following relative sea-level rise the terrigenous supply drastically reduced, temperate-water carbonate systems restored, and the erosional transgression started again producing a long-term ravinement surface (**IV**). We suggest that the present-day carbonate systems in some settings of western Salento produced after an evolutive stage similar to the **IV** one.

The extensive nearshore zone is dominated by marine erosion and the boring of the substrata and occupies settings comparable to the shoreface/offshore-transition zones in siliciclastic shelf systems and is directly comparable to the shaved shelves of James et al. (1994) reported from southern Australia.

Differences between present-day Australia and Puglia carbonate systems are related to the depht of the level of effective wave abrasion (deeper than 70 m in Australia and not more than 15-20 m in Puglia) and to the skeletal-carbonate association (bryomol dominated in Australia and molechfor dominated in Puglia). Such a profile was inferred also from the study of the Plio-Pleistocene.

Calcarenite di Gravina Formation in Puglia, as this carbonate unit was interpreted to derive from temperate-water shallow-marine carbonate sedimentatin (Tropeano and Sabato, 2000, and references therein).

Shallow-marine carbonate systems can show a very different response to relative sea-level changes in comparison to siliciclastic counterparts (Kendall and Schlager 1981; Schlager 1992; James and Kendall 1992; Handford and Loucks 1993; Hunt and Tucker 1993; Wright and Burchette 1996). Basically, the main difference is that *in situ* production is greatest during relative rise and highstands in carbonate systems (Schlager 1991; Schlager et al. 1994; Pomar and Ward 1995), whereas in siliciclastic systems sediment supply is augmented during times of relative fall and lowstand.

During relative sea-level fall and lowstand two different types of carbonate sedimentation are distinguished; autochthonous material derived from *in situ* production and allochthonous debris, calciclastic sediments mechanically derived from the preceding highstand (Sarg 1988). However, sediment production on carbonate shelves is generally reduced during falls and lowstands because the area for shallow water carbonate production is generally reduced (Schlager 1992; James and Kendall 1992; Handford and Loucks 1993; Hunt and Tucker 1993).

During these times little sediment is derived from the platform top which generally undergoes subaerial diagenesis and karstification rather than mechanical reworking and cannibalization of older deposits to augment sediment supply (e.g. Hunt and Tucker 1993).

Nevertheless, an increase in siliciclastic sediment supply during sea-level falls and lowstands is typical of mixed siliciclastic-carbonate depositional systems where sedimentation is characteristically reciprocal (e.g. Wilson 1967).

In temperate-water carbonate successions either marine condensed sections or hardgrounds form on the middle-outer-shelf/ramp facies in response to a relative sea-level fall as the extensive non-depositional nearshore zone characteristic of non-tropical carbonate shallow-marine systems shifts offshore (e.g. Boreen and James 1995). During relative sea-level rise and highstands, tropical and temperate-water carbonates show a very different reaction. Tropical factories are characterized by high-production rates and, during relative sea level rises, carbonate sedimentation may match the rapide increase of accommodation space producing aggradation.

During relative highstand, tropical carbonate production may completely fill the accommodation space (i.e. Pomar and Ward, 1994; Hunt and Tucker, 1995). In contrast, temperate-water carbonate factories are characterized by relatively low-production rates, and drowning is the fate of foramol-type deposional systems during relative sea-level rises (Simone and Carannante, 1988). A rapid transgression led the system to move landward than the previous lowstand position, and is dominated by ravinement processes, by the reworking of older soft-sediments (palimpsest facies) on the sea-bottom, and by the exhumation of the bedrock in nearshore environments, as observed in the Plio-Pleistocene examples of Puglia (Tropeano and Sabato, 2000).

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